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(54) **Electromagnetically driven valve**
Elektromagnetisch angetriebens Ventil
Soupape à commande électromagnétique

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Description

[0001] The invention generally relates to an electromagnetically driven valve and, more particularly, to a pivot-type electromagnetically driven valve for use in an internal combustion engine which is driven by elastic force and electromagnetic force.

[0002] Related-art electromagnetically driven valves are disclosed in, for example, U.S. Patent No. 6,467,441.

[0003] In the case where a related-art electromagnetically driven valve employs a plurality of discs, there is a problem that precision control cannot be achieved if it is attempted to control the valve by sensing the movement of a single disc via a single sensor, since the discs do not move uniformly due to dimensional tolerances and mounting precision.

[0004] Another problem with the related art is that when the discs are in a neutral position, the air gap is large, and the valve cannot be moved easily unless increased electric power is supplied.

[0005] Still another problem is that, due to variations in dimensions and mounting precision, the core and the discs do not make completely close contact with each other, and therefore fail to obtain desired electromagnetic force, resulting in unstable operation of the valve.

[0006] Accordingly, it is an object of the invention to provide an electromagnetically driven valve capable of reliable operation.

[0007] According to one aspect of the invention an electromagnetically driven valve that operates by a combination of electromagnetic force and elastic force includes a valve element that has a valve shaft and that reciprocates in directions of extension of the valve shaft, a first oscillating member and a second oscillating member that extend from driving ends to pivoting ends, and that pivot about central axes extending at the pivoting ends, as well as an electromagnet that oscillates the first oscillating member and the second oscillating member. The driving ends are operatively linked with the valve element. The electromagnetically driven valve also includes a first measuring portion and a second measuring portion that measure at least one of an oscillation angle, an amount of lift and an oscillating speed of the first oscillating member and the second oscillating member, and a control portion that computes energization control logics based on measurement values provided by the first measuring portion and the second measuring portion, and that averages the energization control logics to control energization of the electromagnet.

[0008] Since the electromagnetically driven valve in the one aspect performs control by averaging the movements of the plurality of oscillating members, the control in this aspect achieves higher precision than the control that is based on the movement of one disc on the assumption that the other disc or discs move in the same manner. Thus, it is possible to provide an electromagnetically driven valve capable of reliable operation.

[0009] In the aspect, the control portion may determine an amount of electric current supplied to the electromagnet and a duration of flow of electric current through the electromagnet.

[0010] In the aspect, the electromagnet may include a plurality of coils, and the plurality of coils may be connected with each other, or separated.

[0011] According to the invention, it is possible to provide an electromagnetically driven valve capable of reliable operation.

[0012] The foregoing and/or further objects, features and advantages of the invention will become more apparent from the following description of preferred embodiment with reference to the accompanying drawings, wherein

> FIG. 1 is a cross-sectional view of an electromagnetically driven valve in accordance with a first embodiment of the invention.

[0013] An embodiment of the invention will be described hereinafter with reference to the accompanying drawings.

[0014] Hereinafter, an embodiment of the invention will be described. FIG. 1 is a cross-sectional view of an electromagnetically driven valve in accordance with the embodiment of the invention. The electromagnetically driven valve 1 in accordance with the embodiment of the invention has a main body 51, an electromagnet 60 attached to the main body 51, and an upper disc 30 and a lower disc 1030 located at opposite sides of the electromagnet 60, as well as a valve element 14 that is driven by the discs 30, 1030.

[0015] The main body 51 is a base member, to which various components are attached. The electromagnet 60 is attached to the main body 51 has a core 61 that is made of a magnetic material, and coils 62, 162 wound on the core 61. Energization of the coils 62, 162 creates magnetic fields, which drive the disc 30 and the disc 1030. The discs 30, 1030 are disposed so as to sandwich the electromagnet 60, and one of the discs 30, 1030 is attracted to the electromagnet 60. Thus, the discs 30, 1030 both reciprocate in such a direction as to approach the electromagnet 60 and in such a direction as to move away from the electromagnet 60. The reciprocating movements thereof are transferred to a valve stem 12 via a stem 1012.

[0016] The electromagnetically driven valve 1 is an electromagnetically driven valve that operates by combination of electromagnetic force and elastic force. The electromagnetically driven valve 1 includes the valve element 14 that has the valve stem 12 as a valve shaft and that reciprocates in the directions (arrows 10) of extension of the valve stem 12, and the main body 51 as a support member that is provided at a position spaced from the valve element 14. The electromagnetically driven valve 1 further includes the discs 30, 1030 as first and second oscillating members that extend from driving ends 32, 1032 to pivoting ends 33, 1033, and that pivot about central axes 35, 1035 extending at the pivoting ends 33, 1033. The driving ends 32, 1032 are operatively linked with the valve stem 12. The electromagnet 60 that oscillates the discs 30, 1030, first and second measuring portions 1001, 1002 that measure at least one of the oscillation angle, the amount of lift and the oscillating speed of the discs 30, 1030, and an ECU (electronic control unit) 1000 as a control portion that computes energization control logics on the basis of measurement values provided by the first and second measuring portions 1001, 1002, and that performs a process of averaging the various energization control logics and accordingly controls the energization of the electromagnet. In the invention, energization control logic is a control logic that controls the amount of electric current through the coil 62, 162 of the electromagnet 60 that oscillates the discs 30, 1030. In the energization control logic, the current value is maintained larger than 0A.

[0017] The electromagnetically driven valve 1 in this embodiment is adopted for the intake valves or exhaust valves of internal combustion engines such as gasoline engines, diesel engines, etc. Although in this embodiment, the valve element 14 is an intake valve disposed in an intake port 18, the invention is also applicable to a valve element provided as an exhaust valve.

[0018] The electromagnetically driven valve 1 is a pivot drive type electromagnetically driven valve, and employs two discs, that is, the discs 30, 1030, as a motion mechanism. The main body 51 is provided on a cylinder head 41. In the main body 51, the disc 1030 is provided at a lower side, and the disc 30 is provided at an upper side. The electromagnet 60 is positioned between the disc 30 and the disc 1030. The electromagnet 60 includes the core 61 formed by stacking electromagnetic steel plates, and the coils 62, 162 wound on the core 61 for creating magnetic fields. Supplying electric current through the coils 62, 162 creates magnetic fields in regions surrounded by the coils 62, 162. Due to these magnetic fields, the electromagnet 60 can pull the disc 30 and the disc 1030. Specifically, due to a control of the timing of supplying current through the coils 62, 162, the electromagnet 60 can pull the disc 30 or the disc 1030.

[0019] The coil 62 facing the disc 30, and the coil 162 facing the disc 1030 may be interconnected or separated from each other. The number of turns of each coil 62, 162 on the core 61 is not particularly limited.

[0020] Each of the disc 30 and the disc 1030 has an arm portion 31, 1031 and a bearing portion 38, 1038. The arm portion 31, 1031 extends from the driving end 32, 1032 to the pivoting end 33, 1033. Each arm portion 31, 1031 is a member that is attracted by the electromagnet 60 so as to oscillate (pivot) in the directions indicated by arrows 30a. The bearing portion 38, 1038 is provided at an end of the arm portion 31, 1031. The arm portions 31, 1031 are pivotable about the bearing portions 38, 1038. An upper surface 1131 of the arm portion 1031 is capable of contacting a face of the electromagnet 60 where the coil 162 is provided. Likewise, a lower surface 231 of the arm portion 31 is capable of contacting a face of the electromagnet 60 where the coil 62 is provided. In addition, a lower surface 1231 of the arm portion 1031 is in contact with the valve stem 12.

[0021] Each bearing portion 38, 1038 has a cylindrical shape, and has therein a torsion bar 36, 1036. A first end portion of the torsion bar 36, 1036 is fitted to the main body 51 by spline fitting, and the other end portion thereof is fitted to the bearing portion 38, 1038. Therefore, when the bearing portion 38, 1038 is pivoted, a force opposing this pivot is transferred from the torsion bar 36, 1036 to the bearing portion 38, 1038. Thus, each bearing portion 38, 1038 is always urged toward a neutral position.

[0022] The disc 1030 receives, on the driving end 1032 side, receives force from the disc 30 via the stem 1012, and therefore presses the valve stem 12. A hydro-lash adjuster or the like may be provided between the valve stem 12 and the disc 1030. The valve stem 12 is guided by stem guide 45, 43. The first measuring portion 1001 and the second measuring portion 1002 are attached to the main body 51. The first measuring portion 1001, and the second measuring portion 1002 face the upper surface 131 of the disc 30, and the lower surface 1231 of the disc 1030, respectively. They measure at least one of the oscillation angle (pivot angle), the amount of lift, and the oscillating speed of the disc 30 and the disc 1030.

[0023] Measurement data obtained via the first measuring portion 1001 and the second measuring portion 1002 is sent to the ECU 1000. On the basis of the values obtained from the first measuring portion 1001 and the second measuring portion 1002, the ECU 1000 determines at least one of the magnitude of electric current supplied through the coils 62, 162, and the supplying timing. More specifically, there is slight difference between the oscillating movements (the oscillation angle, the amount of lift, the oscillating speed) of the disc 30 and the oscillating movements of the disc 1030. Therefore, the ECU 1000 averages the energization control logics which are computed based on the data regarding the disc 30 measured by the first measuring portion 1001 and the data regarding the disc 1030 measured by the second measuring portion 1002. The ECU 1000 computes energization control logic for electrifying the coils 62, 162 on the basis of the average value, that is, supplying electric current through the coils 62, 162.

[0024] The ECU 1000 has a function of determining the amount of electric current supplied to the coils 62, 162 and the duration of flow of electric current therethrough.

[0025] The main body 51 of the electromagnetically driven valve 1 is mounted on the cylinder head 41. The intake port 18 is provided in a lower portion of the cylinder head 41. The intake port 18 is a path for introducing intake air into a combustion chamber. That is, air-fuel mixture or air passages through the intake port 18. A valve seat 42 is provided between the intake port 18 and the combustion chamber. By the valve seat 42, the salability of the valve element 14 can be enhanced.

[0026] The valve element 14 as an intake valve is mounted in the cylinder head 41. The valve element 14 includes the valve stem 12 extending in the longitudinal directions, and a bell portion 13 attached to an end portion of the valve stem 12. The valve stem 12 is guided by a stem guide 43. The valve element 14 is capable of being reciprocated in the directions indicated by the arrows 10.

[0027] A spring retainer 19 is fitted over the valve stem 12. The spring retainer 19 is urged by a valve spring 17. Therefore, the valve stem 12 receives upward force from the valve spring 17.

[0028] Next, operations of the electromagnetically driven valve in accordance with the first embodiment will be described. Firstly, to drive the electromagnetically driven valve 1, electric current is supplied to the coils 62, 162 of the electromagnet 60. Thereby, the coils 62, 162 create magnetic fields, so that one of the arm portion 31 of the disc 30 and the arm portion 1031 of the disc 1030 which are both made of a magnetic material is pulled to the electromagnet 60. Which one of the discs is pulled toward the electromagnet 60 is determined by the electromagnetic force generated between the electromagnet 60 and the discs, and the torsion forces of the torsion bar 36, 1036.

[0029] In this embodiment, it is assumed that the disc 1030 is pulled to the electromagnet 60. In this case, the arm portions 31, 1031 pivot upward. Therefore, the torsion bars 36, 1036 are twisted, so that the torsion bars 36, 1036 tend to move the arm portions 31, 1031 in the opposite direction. However, due to the strong pulling force of the electromagnet 60, the arm portions 31, 1031 pivot upward until finally the upper surface 1131 of the arm portion 1031 contacts the electromagnet 60. As the arm portions 31, 1031 move upward, the valve stem 12 also moves upward. In this manner, the valve element 14 is closed.

[0030] To open the valve element 14, the arm portions 31, 1031 need to be moved downward. To that end, the current flowing through the coil 162 is stopped or reduced. As a result, the electromagnetic force acting between the electromagnet 60 and the arm portion 1031 reduces. The torsion force (elastic forces) acting on the arm portions 31, 1031 from the torsion bars 36, 1036 overcomes the electromagnetic force, so that the arm portions 31, 1031 move to the neutral position as shown in FIG. 1. At this time, the valve stem 12 of the valve element 14 is pushed by the arm portions 31, 1031 to move downward. Then, electric current is supplied to the coil 62. As a result, a magnetic field is created around the coil 62, and the arm portion 31 made of a magnetic material is pulled to the electromagnet 60.

[0031] At this time, too, the valve stem 12 of the valve element 14 is pushed by the arm portions 31, 1031 to move downward. The pulling force of the electromagnet 60 overcomes the torsion force of the torsion bars 36, 1036, so that finally the lower surface 231 of the arm portion 31 contacts the electromagnet 60. At this time, the valve element 14 moves downward to assume an open valve state. By alternating the upward movement and the downward movement as described above, the arm portions 31, 1031 pivot back and forth in the directions indicated by the arrows 30a. As the arm portions 31, 1031 pivot, the bearing portions 38, 1038 connected to the arm portions 31, 1031 also pivot.

[0032] The oscillation angle, the amount of lift and the oscillating speed of the discs 30, 1030 are measured by the first measuring portion 1001 and the second measuring portion 1002, respectively. On the basis of individual movements of the discs 30, 1030, the ECU 1000 prepares dedicated control logics for the discs 30, 1030 separately. By combining these control logics, the ECU 1000 determines the amount of electric current supplied to the coils 62, 162 and the duration of energization so as to control the electromagnet 60.

[0033] In the above-described electromagnetically driven valve 1 in accordance with the first embodiment, the control of energization of the electromagnet 60 is performed on the basis of the movements of the two discs 30, 1030, so that the precision of the control improves as compared with the case where only one disc is monitored to perform the energization control. Therefore, it becomes possible to provide an electromagnetically driven valve capable of reliable operation.

[0034] It is to be understood that the embodiment disclosed herein is merely illustrative and not restrictive in any respect. It is intended that the scope of the invention is indicated by the appended claims, not by the foregoing description, and covers all the modifications that are within the scope of the claims and the meaning and scope of equivalents.

[0035] This invention can be used, for example, in the field of electromagnetically driven valves for internal combustion engines that are mounted in vehicle.

[0036] An electromagnetically driven valve (1) includes a valve stem (12), a valve element (14) that reciprocates in the directions of extension of the valve stem (12), and an upper disc (30) and a lower disc (1030) that extend from driving ends (32, 1032) to pivoting ends (33, 1033), and that pivot about central axes (35, 1035) extending at the pivoting ends (33, 1033). The driving ends (32, 1032) are operatively linked with the valve element (14), An electromagnet (60) oscillates the upper disc (30) and the lower disc (1030). First and second measuring portions (1001, 1002) measure at least one of the oscillation angle, the amount of lift and the oscillating speed of the upper disc (30) and the lower disc (1030). An ECU (1000) as a control portion computes energization control logics on the basis of measurement values provided by the first and second measuring portions (1001, 1002), and averages the various energization control logics and accordingly controls the energization of the electromagnet (60).

Claims

1. An electromagnetically driven valve that operates by a combination of electromagnetic force and elastic force, comprising

   a valve element (14) that has a valve shaft (12) and that reciprocates in directions of extension of the valve shaft (12);
   a first oscillating member (30) and a second oscillating member (1030) that each extend from driving ends (32, 1032) to pivoting ends (33, 1033), and that pivot about central axes (35, 1035) extending at the pivoting ends (33, 1033), wherein the driving ends (32, 1032) are operatively linked with the valve element (14);
   an electromagnet (60) that oscillates the first oscillating member (30) and the second oscillating member (1030);
   a first measuring portion (1001) and a second measuring portion (1002) that measure at least one of an oscillation angle, an amount of lift and an oscillating speed of the first oscillating member (30) and the second oscillating member (1030); and
   a control portion (1000) that computes energization control logics based on measurement values provided by the first measuring portion (1001) and the second measuring portion (1002), and that averages the energization control logics to control energization of the electromagnet.

2. The electromagnetically driven valve according to claim 1, wherein the control portion (1000) determines an amount of electric current supplied to the electromagnet (60) and a duration of flow of electric current through the electromagnet (60).

3. The electromagnetically driven valve according to claim 1, wherein the electromagnet (60) includes a plurality of coils (62, 162), and the plurality of coils (62, 162) are connected with each other.

4. The electromagnetically driven valve according to claim 1, wherein the electromagnet (60) includes a plurality of coils (62, 162), and the plurality of coils (62, 162) are separated.

Patentansprüche

1. Elektromagnetisch angetriebenes Ventil, das durch eine Kombination einer elektromagnetischen Kraft und einer Federkraft arbeitet, umfassend

   ein Ventilelement (41), das eine Ventilstange (12) aufweist und das sich in Erstreckungsrichtungen der Ventilstange (12) hin- und herbewegt,
   ein erstes Schwingungselement (30) und ein zweites Schwingungselement (1030), die sich jeweils von Antriebsenden (32, 1032) zu Schwenkenden (33, 1033) erstrecken, und die sich um Mittelachsen (35, 1035) drehen, die sich bei den Schwenkenden (33, 1033) erstrekken, wobei die Antriebsenden (32, 1032) betriebsfähig mit dem Ventilelement (14) verbunden sind,
   einen Elektromagneten (60), der das erste Schwingungselement (30) und das zweite Schwingungselement (1030) in Schwingung versetzt,
   einen ersten Messabschnitt (1001) und einen zweiten Messabschnitt (1002), die zumindest einen Schwingungswinkel, eine Hubgröße und/ oder eine Schwingungsgeschwindigkeit des ersten Schwingungselements (30) und des zweiten Schwingungselements (1030) messen, und
   einen Steuerungsabschnitt (1000), der auf der Grundlage von Messwerten, die durch den ersten Messabschnitt (1001) und den zweiten Messabschnitt (1002) bereitgestellt werden, eine Energieversorgungssteuerlogik berechnet, und der die Energieversorgungssteuerlogik mittelt, um eine Energieversorgung des Elektromagneten zu steuern.

2. Elektromagnetisch angetriebenes Ventil nach Anspruch 1, wobei der Steuerungsabschnitt (1000) eine Größe eines dem Elektromagneten (60) zugeführten elektrischen Stromes und eine Flussdauer des elektrischen Stromes durch den Elektromagneten (60) bestimmt.

3. Elektromagnetisch angetriebenes Ventil nach Anspruch 1, wobei der Elektromagnet (60)eine Vielzahl von Spulen (62, 162) umfasst, wobei die Vielzahl von Spulen (62, 162) miteinander verbunden ist.

4. Elektromagnetisch angetriebenes Ventil nach Anspruch 1, wobei der Elektromagnet (60) eine Vielzahl von Spulen (62, 162) umfasst, wobei die Vielzahl von Spulen (62, 162) getrennt ist.

Revendications

1. Soupape à commande électromagnétique qui fonctionne par la combinaison d'une force électromagnétique et d'une force élastique, comprenant
   un élément de soupape (14) qui comprend une tige de soupape (12) et qui effectue un mouvement de va-et-vient dans des directions d'extension de la tige

de soupape (12);
un premier élément oscillant (30) et un deuxième élément oscillant (1030) qui s'étendent chacun depuis des extrémités motrices (32, 1032) vers des extrémités pivotantes (33, 1033), et qui pivotent autour d'axes centraux (35, 1035) s'étendant au niveau des extrémités pivotantes (33, 1033), où les extrémités motrices (32, 1032) sont reliées de manière opérationnelle à l'élément de soupape (14);
un électroaimant (60) qui fait osciller le premier élément oscillant (30) et le deuxième élément oscillant (1030);
une première partie de mesure (1001) et une deuxième partie de mesure (1002) qui mesurent au moins l'un d'un angle d'oscillation, d'une quantité de levée et d'une vitesse d'oscillation du premier élément oscillant (30) et du deuxième élément oscillant (1030); et
une partie de commande (1000) qui calcule des logiques de commande d'excitation sur la base de valeurs de mesure pourvues par la première partie de mesure (1001) et la deuxième partie de mesure (1002), et qui calcule la moyenne des logiques de commande d'excitation pour commander l'excitation de l'électroaimant.

2. Soupape à commande électromagnétique selon la revendication 1, dans laquelle la partie de commande (1000) détermine une quantité de courant électrique alimenté à l'électroaimant (60) et une durée du flux de courant électrique à travers l'électroaimant (60).

3. Soupape à commande électromagnétique selon la revendication 1, dans laquelle l'électroaimant (60) comporte une pluralité de bobines (62, 162), et la pluralité de bobines (62, 162) sont reliées les unes aux autres.

4. Soupape à commande électromagnétique selon la revendication 1, dans laquelle l'électroaimant (60) comporte une pluralité de bobines (62, 162), et la pluralité de bobines (62, 162) sont séparées.

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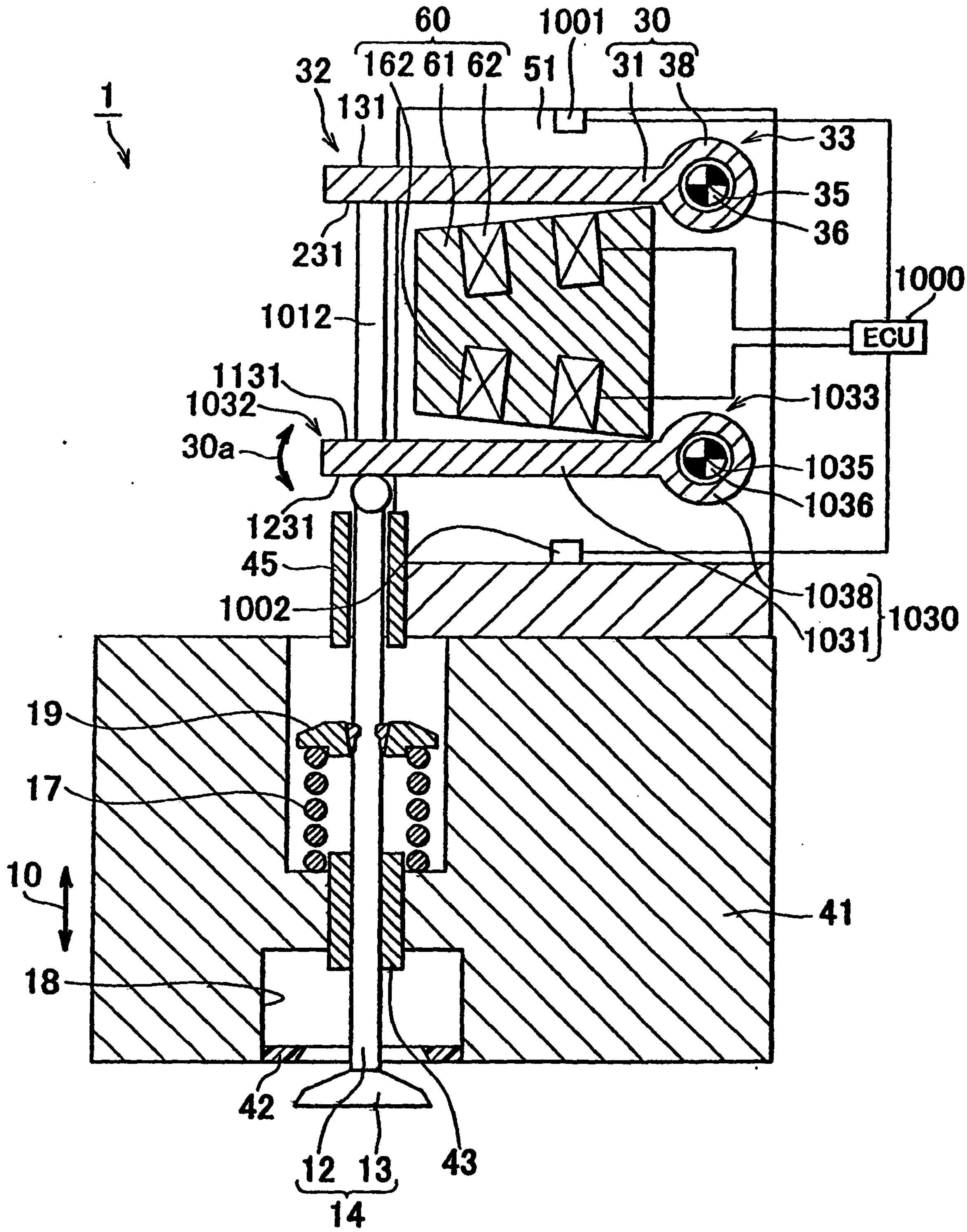
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REFERENCES CITED IN THE DESCRIPTION

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